2nd International Near-Field Optical Analysis Conference

Summary and Significance to NASA and DARPA

Potential New Biomedical Treatments

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The second international conference on Near-Field Optical Analysis (2nd NOA), a NASA/DARPA photobiology conference, was held May 31 and June 1, 2001, at the USRA Center for Advanced Space Studies in Houston, Texas. The focus was on biological mechanisms and clinical applications of near-field optical analysis (NOA), low level laser therapy (LLLT), and low intensity light-activated biostimulation (LILAB). Near infrared (NIR) in wavelengths between 630 and 880 nm has been used successfully to:

- Increase the rate of tissue repair for open epidermal and connective tissue wounds,
- Treat severe mouth ulcers in immunologically compromised children following radiotherapy
- Treat superficial cuts and severe abrasions, in submariners, and
- Increase the rate of bone regeneration surrounding dental implants. Studies on cultured nerve cells indicate that LLLT also stimulates regeneration of damaged cells in the retina of the eye.

NASA has a keen interest in microgravity-induced alterations of cellular mechanisms of wound healing, especially those that may involve tissue repair following traumatic injuries, compound fractures, infections, and remote medical care during long-term space missions. NASA also has a critical path goal to develop pharmaceutical countermeasures to offset any major retardation of cellular repair of radiation damage, immune cell dysfunction, and increased virulence or antibiotic resistance of infectious organisms.

Astronaut and cosmonaut experiences have indicated that normal healing of superficial skin wounds is retarded during flight, similar to the delayed healing observed during long-term submerged operations on submarines. Photodynamic therapy using NIR light has been shown to enhance wound repair via several molecular mechanisms, involving absorption by cytochrome C in the mitochondria, enhancement of intracellular signalling, gene expression and subsequent cytokine secretions. NASA intends to evaluate NIR light therapy as a potential countermeasure to accelerate healing processes, particularly because the 600 – 1000 nm

wavelengths can penetrate 10 to 20 cm of tissue without side effects to adjacent tissues. Much of the research into photodynamic mechanisms has been performed using high intensity lasers and fiber-optic illuminators; NASA, however, has developed less expensive, handheld LED devices, that emit the 630 nm NIR light which is appropriate for photodynamic therapy. NASA's Johnson Space Center has further interest in this research because of ongoing work to microencapsulate photodynamic therapy drugs for new cancer treatments. In addition, NASA JSC has been studying the combined effects of radioprotectants, cytokine inducers, and model microgravity effects on various immune cell functions in randomized gravity experiments using the horizontal rotating bioreactors. Using these cellular models to evaluate the potential benefits of NIR-LLLT is a logical extension of this work, revealing how NIR-LLLT enhances wound healing or increases effectiveness of pharmaceutical countermeasures to the adverse physiological effects of microgravity on molecular mechanisms of wound healing, bone regeneration, nerve regeneration, pain modulation, and biofilm formation processes. Important changes can then be confirmed with microgravity experiments on the International Space Station.

Understanding these molecular mechanisms could also lead to the development of new photosensitising drugs that can enhance wound healing and regeneration of certain tissues for medical therapies on Earth. NASA-developed LED systems that use near-infrared light (600-1000 nm) and the new PDT drug strategies are expected to have potential new biomedical applications in space, on submarines, and under extreme conditions encountered for certain medical treatment in remote regions.

More Information:

Interested persons can obtain a copy of the NASA conference proceedings from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161:

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